

THE UNIVERSITY, THE STATE, AND THE LOSS OF PLANT DIVERSITY

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My roots in Berkeley are deep, a fact that adds to a profound sense of satisfaction on this auspicious occasion. My grandfather was in the first class to graduate from Bolt Hall; his grandfather, Patrick Breen, who came to California in 1846 in the Donner Party, left a diary that is one of the treasures of the Bancroft Library; and my mother graduated from this beautiful campus in the year when the Life Science Building first came into use. For these and many other reasons, I take great personal satisfaction in the presentation of these outstanding new facilities here this evening. It was an extraordinarily satisfying experience for me to enter Berkeley myself as an undergraduate student in 1955, a much-appreciated start to my own career. For these personal reasons, it is a special satisfaction for me to see what an outstanding contribution the University has made to systematic biology by refurbishing these facilities so beautifully: they will serve generations of Californians and others well, and help this proud institution to remain in the forefront of those which recognize the importance of biodiversity as an integral part of the science of biology, as well as for human progress in the future.

There are very few universities that possess the ample resources of specimens, of library materials, of archives, and of people that are present on this campus. In consequence of these assets, the potential for future service is truly impressive. As time goes by, much of the focus will doubtless continue to be on the plants of California, which have interested and delighted all those who have come into contact with them or lived among the hills and valleys of this fascinating, diverse, and truly wonderful State. But the plants and the natural communities of which they are a part have changed drastically just since I was a boy, and they are continuing to change at an alarming rate. What are the dimensions of this problem, and how shall we deal with it?

The fields of wildflowers near the places where we grew up have, in many cases, vanished; the meadowlarks have moved further back into the hills; and California is not the place that it was a few decades ago. I don't feel that I have attained any very great age, and yet I can easily remember driving down to Hollister and San Juan Bautista from San Francisco on basically a two-lane or three-lane road through

orchards, with no freeways anywhere. Such memories of the Bay Area in the 1930's and 1940's illustrate vividly how the region has changed, and in turn instruct us in the importance of caring properly for this State, with all of its biological riches. The University Herbarium, and particularly, the Jepson Herbarium, have central roles to play in this effort, through their studies, through the students who benefit from them, and through the many publics that they serve.

Among the various ways in which people have viewed the natural scene in California, I have always enjoyed Herb Caen's expression: "A true Californian is someone who knows that the hills are naturally a golden brown, which is interrupted briefly in winter by the appearance of a greenish scum, which soon disappears, returning them to their natural glory." I have found delight of a different kind in John Muir's view, when he wrote, remembering a scene that he viewed in April 1868: "Looking eastward from the summit of Pacheco Pass, one shining morning, I found before me a landscape that, after all my wandering, still appears as the most beautiful I have ever beheld. At my feet lay the great central valley of California, level and flowery, like a lake of pure sunshine, forty or fifty miles wide, five hundred miles long, one rich furred garden of yellow Compositae. And from the eastern boundary of this golden flower bed rose the mighty Sierra, miles in height, and so gloriously colored and radiant, it seemed not clothed with light, but wholly composed of it, like the wall of some celestial city. Along the top, and extending a good way down, was a rich pearly gray belt of snow, below it, a belt of blue and dark purple, marking the extension of the forests and stretching along the base of the range, a broad belt of rose purple. All these colors, from the blue sky to the yellow valley, smoothly blending as they do in a rainbow, making a wall of light ineffably fine."

Personally, I became fascinated with the plants of California when I was eight or nine years old. Rather than gaining an interest in natural history, I simply retained my childhood interest, an interest that many lose as they grow older. I can remember as vividly as if it were yesterday crossing over to Marin County and seeing *Sanicula arctopoides* blooming in the spring woods—what a unique and interesting plant! I can also remember visiting Bernal Heights in San Francisco for the first time in spring, searching for what Jepson called *Dodecatheon hendersonii* var. *bernalianum*, and the joy of finding those beautiful flowers in abundance. And then I can remember being in the redwood forests in the Santa Cruz Mountains and seeing *Clintonia andrewsiana*, with its extraordinary blue fruits, for the first time. These were among the plants that impressed me deeply when I was a boy.

Another of the reasons that I am so glad to be here, is the memory of the enormous effect that Jepson's *Manual* had on me: how helpful

it was in my studies of California plants. Here in a single volume one could look up the characteristics and geographical ranges of all the plants of California! Jepson was a master at describing plants. He would use very few words, and they were exactly the words that were most helpful in understanding what a particular plant looked like. Such skills were, of course, based on his lifetime of experience with those plants, and the way that he cherished them, which Lincoln Constance brought out so beautifully for us in his lecture last evening. When I was eight years old, I first visited the student section of the California Academy of Sciences, and was allowed to join in the autumn of 1944. Subsequently, I was invited to meet Alice Eastwood, then 90 years old, to ask her opinion about the identities of some plants that I had collected. So I took my plants, which I had mounted on sheets of herbarium paper, and confronted Miss Eastwood, who was sitting, smiling, in her office. If I seemed to have been a shy undergraduate at Berkeley, you should have seen me at nine years old confronting Alice Eastwood—but I shall always remember how kind she was to me. Among my plants was a specimen of *Rosa gymnocarpa* with a single fruit. On seeing it, Miss Eastwood exclaimed, “Oh, it’s so good that you collected the fruit, because you can see that the sepals have dropped off, and because the specimen is so complete, I can tell you that it is *Rosa gymnocarpa*.” That was certainly a kind and encouraging comment, especially when one remembers that I was a tenth of her age at the time!

With your permission, I would like to dedicate these remarks to the memory of John Thomas Howell, one of those who was encouraged in his pursuit of botany by Jepson. John Thomas Howell was born in Merced, November 6, 1903, and passed away on May 7, 1994 in San Rafael. His 70 years of study of plants, chiefly those of California and the West, and his 54,000 collections, established a permanent record of the plants of California and some of the West during the middle decades of the 20th century.

Tom was encouraged by his parents and particularly by his Merced High School chemistry teacher. Entering Berkeley, he soon fell under the influence of Jepson and decided to major in botany. I believe that it may have been a natural result of the encouragement that he received himself in his early years that he so consistently encouraged others, not only in botany, but generally. Although he was ever anxious to complete his own work, he still was ready to take the time to provide advice and counsel, and to talk about the intricate details of variation that the plants of California exhibit. He shared his delight in those plants—in their beauty, in their variety, and in the wonderful places where they grow—with many people throughout his life.

I became acquainted with Mr. Howell in 1945 or 1946, and there followed a whole series of wonderful opportunities and experiences

for me. For example, I was delighted when I found what was then called *Pentachaeta bellidiflora* at a new locality in Marin County just in time to get my collection incorporated into the first edition of *Marin Flora*. It was at Tom's suggestion that I joined the Sierra Club, becoming about the 18,500th member in 1948, at the age of 12; Tom had been active in the Club since the early 1940's. I visited the Sierra Club lodge at Norden in 1949, and again in 1950, and that's when my plant collecting began to get serious, and I began to consult the Academy herbarium. I well remember going there and trying to figure out what *Stipa lemmonii* was, and how it could be distinguished from related species, having no idea that much later it would be blessed with the name *Achnatherum*! At about the same time, I began writing articles, initially for *Leaflets of Western Botany*, a journal that was established by Alice Eastwood and Tom Howell in 1931, and was published until 1968. The journal was filled with Howelliana such as "A botanist gambles in Reno" and "Two confused western daisies," containing a rich store of knowledge about plants, and especially about the plants of California. In that same period of my life, and still with some discomfort after all of the intervening years, I can remember Tom telling me, after I had written my first few short articles, that I had mastered the necessary jargon, and could go on writing articles forever, whether I had anything to say or not!

In those years also I had the wonderful pleasure of joining the 1950 Sierra Club Base Camp trip, where I first met Ledyard Stebbins and his daughter Edie, thus initiating a lifelong friendship with that remarkable man, who has contributed so much to the study and understanding of California plants and of plants generally. You can imagine what a treat it was for me, at the age of fourteen, to be sharing a tent with Ledyard, who was then still at Berkeley, about to publish his monumental *Variation and Evolution in Plants*, just on the verge of moving permanently to Davis. Through him that summer I began to glimpse the power of evolutionary studies, and the joy associated with the understanding that such a perspective brought. My subsequent years at Berkeley, and in graduate school at UCLA, where I studied with Harlan Lewis, were very happy ones, and so it has been all of my professional life, for which I am truly grateful.

Allow me to share with you a few more thoughts about Tom Howell. At a time when getting everything done as rapidly as possible, publishing as much as widely as possible, and working toward the improvement of our material status threaten to become universal goals, I recall, for some curious reason, Tom's lifelong delight in the way that the specimen of *Iris hartwegii* that he pressed when he went to Wawona as a counselor at the end of his first year at Berkeley, retained the color of its flowers. It was a beautiful specimen, and he

took great satisfaction in that simple fact. I think that his appreciation of his modest accomplishment might, in some way, be taken to represent for us the kind of depth and fullness of experience that is possible, and that certainly help to make botany, and perhaps even life, really worthwhile.

Tom Howell had a great sense of fun. He loved plants and people. He was thoughtful and generous with his time. He really was a fine role model, and I'm glad to have known him so well during my teen years. One thing that he forced me to do was to prepare handwritten herbarium labels, which were the only kind that he considered authentic. After I wrote a few, and he saw that they were illegible, he insisted that I improve my handwriting—not a bad idea at all. During my teenage years, I volunteered in the Academy's botany department, for example breaking down Henry Pollard's often massive herbarium specimens from the Ojai Valley so that they could be mounted. Years later, I remarked to Mr. Howell that I used to greatly enjoy coming in after school and volunteering, whereupon he reminded me of the "bait," a Hershey bar that he placed each day in the drawer of my desk!

Let us turn now to the plants of California. Exactly two centuries ago, in 1794, Captain George Vancouver was sailing away from the coast of California, the third European expedition to bring back some knowledge of our plants. Among other regions, he visited the Monterey area, and near Santa Cruz, Archibald Menzies, a scientific passenger on the voyage, discovered redwoods—the plants of the west coast began to be understood for the first time. A hundred years later, in 1894, Edward Lee Greene, after nine successful years at Berkeley, was contemplating moving to the Catholic University. During his residence at Berkeley, Greene contributed fundamentally to the establishment of a tradition of resident botanists studying the plants of the State, and laid the foundation for botany on this campus. In that same year, Greene's students, Ivar Tidestrom and Willis Linn Jepson, were helping him to plant the first specimens in the young botanical garden that they were building along Strawberry Creek. And I couldn't help thinking, as I was walking down through the campus this afternoon, that they must have enjoyed seeing some of the same California laurel trees and hearing the calls of the ancestors of the same blue jays that we hear there today. Such thoughts provide a peaceful sense of continuity, as well as a vision of a long and prosperous future, for this institution.

There are some 18,000 species of vascular plants in the United States and Canada, about a third of them occurring within the borders of California. About 5000 of those are native, about a quarter of them endemic to the State. For the California Floristic Province, west of the mountains and the deserts, but including southwestern Oregon and northwestern Baja California, there are about 4000 na-

tive species, about half of them endemic, including about 50 endemic genera. By world standards, those are impressive totals; and the intricate patterns of variation of our plants, related to the intricacies of our geography, are as complex and interesting as those found anywhere.

The University, its herbarium, and the Jepson Herbarium in particular, with its specimens, library, and professional staff, is in a unique position to contribute to the interpretation and increase of information about those plants in the future, as it has done in the past. The herbarium includes about 1.7 million species, with about as many at the California Academy of Sciences, including the Dudley Herbarium—probably nearly four million specimens in the Bay Area as a whole, and thus one of the world's largest collections of plants. The Berkeley campus likewise is home to one of the world's premier botanical gardens, in terms of native-collected and documented material. The development of the garden over the past 30 years has been extraordinary, and is a real tribute to the efforts of Bob Ornduff and others who have served as directors during that period of time, as well as the talented staff members who have helped to assemble this remarkable resource. Those members of the general public who have supported the garden through thick and thin are likewise to be congratulated for what they have helped to achieve.

The potential for service for Berkeley in the future is based squarely on the fact that its herbarium, library, and garden are parts of a great university, with all of its wonderful and diverse educational possibilities, with scholars representing many disciplines, with other libraries, with world-class computer facilities, and all of the assets that an institution of this quality and scope confers. This complexity and richness allows students and the public to celebrate and learn about plants in all of their diversity and in all of the ways in which they relate to humans. A great urban center, located in a region that is home to one of the most fascinating floras in the world, and in a State that is known for global leadership—these are certainly the ingredients of greatness.

Now let us consider the discipline of systematics. Systematics is a composite discipline that requires a number of different skills and operates through several more-or-less distinct stages. First, as Barbara Ertter has often stressed well, the primary factor that underlies systematics and makes it possible is the ability to find and to understand organisms as they exist in nature. Excited by the many new and rapidly growing fields of investigation associated with modern biology, we sometimes forget that it is the actual plants, their ranges and other features, and their status that we need to investigate first. Without the continuous acquisition of such knowledge, so fundamental for everything else; without the ability to recognize and distinguish the kinds of organisms; without the careful documentation

of what we learn in biological collections, nothing else in systematic or evolutionary biology is possible. For example, E.O. Wilson has often pointed out termites and ants together comprise about a third of the animal bio-mass in the world, but there are only about twenty scientists who actually have the ability to identify and to classify them systematically. The picture for fungi is even worse, despite the economic and ecological importance of these organisms, and the fact that we have so far named fewer than 70,000 of an estimated 1.5 million species. Difficulties in interpreting the taxa of endangered and threatened groups of plants in California, such as those of the *Chorizanthe valida* group, illustrate a similar point: regardless of our laws, we cannot act on them without understanding the limits of the taxa involved. Only a scientist who is knowledgeable about a particular group of organisms can sort them out properly, understand them, and interpret their patterns of variation. Without such knowledge and the associated studies and documentation, nothing else in biology can be accomplished in a comparative, evolutionary context: cladistics, macromolecular studies, biogeography, every elegant approach to the diversity of life on Earth is impossible, irreproducible, and trivial. Can most macromolecular comparisons between organisms be replicated? Only if there are vouchers—in a world where less than 15% of the total kinds of organisms have even been named, it is not good enough to assume that all are known, and that any sample will do.

In terms of learning about the plants of California properly, we can reasonably take delight in the activities of state agencies, The Nature Conservancy, private consultants, the California Native Plant Society, and similar organizations, but we still need the Jepsons, the Eastwoods, the Howells, the Ferrises, the Constances, the Ornduffs, the Mishlers, and some of these individuals will best be located in universities, where they are able to educate students and to provide, if you will, a kind of a scholarly bridge, a foundation, for all of the people and agencies that are concerned with the plants of the State. Without that essential ingredient—without a serious study of these organisms and how to recognize them, to interact with them, and to train students in the universities and in the academic places—we won't have the kind of comprehensive system that we really need in order to deal with the plants of California.

And it is diversity that makes biology interesting and worthwhile. Our knowledge of diversity, our ability to deal with it, and to understand what and where it is, is the basis of all of a great many of our human activities, whether we are dealing with aesthetics, art, poetry, management, restoration ecology, controlling weeds, growing lush lawns or fascinating displays of native plants, practicing better agriculture, undertaking genetic engineering, or conserving the organisms that nurture and sustain our lives. Without that funda-

mental devotion to learning about organisms, nothing else is meaningful.

The second major area of botanical studies that I would like to emphasize concerns the synthesis of information—the production of classifications. Although we are all deeply and properly impressed with the power of cladistic methods of analysis, and with the exciting new information that is becoming available as a result of macromolecular comparisons, as well as with the importance of information retrieval, it is ultimately the scientific process of classification—of grouping organisms into meaningful units—that makes possible everything else in systematic, evolutionary, and environmental biology, and which ultimately gives meaning to all of biology. A community-based project such as the *Flora of North America*, a program that involves about 30 collaborating institutions throughout the United States and Canada; hundreds of individuals; and a very careful and rigorous editorial process, basically depends on a rigorous scientific process in the course of which the kinds of plants that occur in the region are recognized and delineated. It is misleading, virtually tragic, to assume that everything is known about these plants, and that the units can be recognized as easily as looking up widgets in a Sears Catalogue, or a Peterson guide to the birds of a given area. To inventory, to understand, the plants of the region, science and agreement are necessary first; once that synthetic and community-wide process has been completed, then and only then it becomes possible to computerize the data, pop label information into a computer, get it back out, and stockpile the additional data that are accumulated for future use. When we become so fascinated with the rather simple technology of information retrieval that we forget what surveying and inventorying organisms is all about, then we forget our science and lose the opportunity to understand organisms properly. It is very useful to write legible labels, to store specimens in a logical system, and to be able to retrieve the information that is recorded on their labels—but it isn't science.

Science is synthesis, and agreement, and investigation, and badly needs our continued attention, and our support. *Flora of North America* is not a specimen-based atlas of the plants of North America, but rather an international, community-based program that will ultimately provide a sound, scientific basis of classification for the plants of the region that is necessary for such a technical exercise to be meaningful. To appreciate my point, consult the treatments of *Botrychium* or *Eriogonum* in the flora, and consider what computerizing the labels of those groups would have meant without the synthetic, continental account represented by the book!

Moving to another important area of activity in systematic biology, consider biosystematics. California is the place where much

of this synthetic area has developed, a relationship that is perhaps not surprising considering the remarkable flora of the State and the outstanding institutions located in it. Some of the deepest roots of biosystematics extend from the experiments of which Harvey Monroe Hall, then at Berkeley, was really the guiding light; he put together the team that made it happen. Although biosystematics has flourished in California, and a great deal of information is available about some groups of plants here, a great deal remains to be done.

For the overall advance of understanding plant evolution in the region, and generally, it would be desirable to select plants with characteristics that differ from those of the groups that have been studied more or less comprehensively already. Now here's an area where collaboration between botanical gardens and herbaria systematic botanists is really important. For example, we know a lot about the biosystematics of tarweeds, *Potentilla glandulosa*, and of *Lasthenia*, but we know next to nothing about the analogous features of *Arctostaphylos*, *Garrya*, or *Fremontodendron*. In principle, the appropriate studies could be carried out in botanical gardens, where the experimental hybrids could be made and examined years later when they reached reproductive maturity. Although investigations of this sort are not suitable for doctoral dissertations, people who have long-term employment and access to the necessary field space might appropriately plan such experiments and carry them out. Doing so would enhance our knowledge of patterns of variation and evolution of some very different groups of California plants greatly, and assist in the development of a synthetic theory of plant evolution. What sorts of reproductive barriers exist in these groups of woody plants, how has past hybridization affected them, how do they vary in cultivation—these are all questions that should be addressed in a comprehensive way.

Now let's consider the area of phylogenetic analysis. We now have access to many wonderful experimental and analytical techniques, techniques that will allow us to determine clearly, and at long last, whether *Simmondsia* belongs to the Buxaceae or not, or in the Euphorbiaceae, or if it doesn't, what are its relatives? For that matter, is Euphorbiaceae a homogeneous family, or a collection of divergent groups linked by a superficial similarity? As a result of our ability to provide secure answers to such questions, we are clearly living in the most exciting period ever for the study of plant phylogeny, a period in which we shall understand well for the first time the phylogenetic structures of individual families, the relationships of families, and the evolutionary history of phyla and kingdoms of organisms. Within no more than a decade, we shall have achieved a relatively complete solution to problems that have preoccupied botanists for centuries, and a vision of plant evolution that will exceed

anything we can imagine now. With such a framework, the analysis of other features of plants, such as reproductive biology, embryology, and the nature of secondary metabolites, will be enhanced greatly, becoming increasingly productive and interesting.

Finally, I would like to mention the area of information retrieval, treated narrowly as a virtual synonym of electronic data processing by most people today. Given the millions of poorly-understood species of organisms that exist, with essentially unlimited observations possible about each of them, it is obvious that such methods must be applied as a matter of simple common sense. Indeed, it is increasingly difficult to imagine significant progress in the field without them: the actual and potential data are simply too extensive. Consider the hundreds of millions of herbarium specimens, or the estimated 25 million mounted prepared specimens of insects in The Natural History Museum, London—resources that obviously can be utilized on a wide scale only by organizing and thus making available the information that they represent. Noteworthy in this area is the Museum Informatics Program here at Berkeley, which has been an important contributor to advances in this field for a number of years.

An important aspect of the formation of electronic data bases is that it no longer matters much in principle how individual herbaria are organized, or whether they are physically combined or not—except in terms of efficiency of storage arrangements. The evident growing collaboration between the University Herbarium at Berkeley, the California Academy of Sciences and Dudley Herbarium, and other similar institutions in the State is an important element in the management of plant resources in California, including their conservation, and one that richly deserves direct State support. The growing numbers of vouchers that are being produced as a result of the operation of State and Federal programs need to be accumulated efficiently, and to be entered into the State data base in such a way that their existence will expedite further research and more effective management plans. In general, the linkages between universities, museums, botanical gardens, the Heritage Program established by The Nature Conservancy, other conservation groups, and all parties interested in the sustainability of California need to be strengthened for the common good. A comprehensive plan for the conservation of California's plants, both in nature and botanical gardens and similar facilities, ought to be organized promptly to serve the mandates of the State and Federal governments in this area effectively. Such a plan should be based on the data that will eventually be gathered into the SMASCH database, which in principle will eventually include the available information about the plants of the State, and provide a means for determining their status on an ongoing basis. Linkages with other nationally significant databases, such as the 600,000 specimens in the database we maintain at the Missouri

Botanical Garden, ought to be forged so that the resulting system can serve global as well as local needs. Access to databases such as that of the Paleontology Museum here, or the Missouri Botanical Garden's database through the World-Wide-Web or gopher systems is becoming standard, both of these databases being consulted by tens of thousands of users monthly.

I know that we share a profound joy in the privilege of studying and learning about one of the most remarkable and beautiful assemblages of plants anywhere on Earth. Moreover, the vision of a network of Californians—amateur, non-academic, professional—all working together around this common theme, is truly impressive. Special praise is due to the California Native Plant Society, with well over 10,000 members throughout the State, and specifically for the role of Ledyard Stebbins in inspiring the group during its formative period. Throughout his long and distinguished career, Ledyard has not only contributed fundamentally to our understanding of plant evolution, he has inspired people everywhere with his love of plants and called their attention to the need to appreciate and conserve them. Every resident of California has a right to feel the special joy that we are celebrating here this evening, a joy based on an appreciation of the plants of the State and the intricacies of their biology, a subject of which we never tire. A few dozen species have already been lost in California: let's be certain that there are no more.

Perhaps a network of botanical gardens, or two networks, one in Northern California and one in Southern California, could be organized to address this task. The Center for Plant Conservation, of which there are currently two members, the garden here in Berkeley and Rancho Santa Ana, in California, has implemented a network of this sort in Hawaii, and the ingredients are certainly here for an all-out effort to preserve native plants. Who will take the lead in mounting such an effort?

To conclude with a few major themes, I shall begin with education. The University has an important role to play not only with regard to its students, but for its many publics as well. With a firm focus on organisms, their characteristics and geographical ranges, the University program will always have a great deal to offer in this area, and many willing learners. The kind of commitment that the University has made in this magnificently refurbished Valley Life Science Building marks its commitment to organismal biology, and to continued leadership in this field.

To speak of the role of the State, California remains an extraordinary world leader, despite its recent economic problems. Within California, the Bay Area is a particular center for innovation, and this institution perhaps the strongest public university in the world. In this context, the kind of foresight that Robert Gordon Sproul

exhibited in building the university during the Great Depression provides inspiration—the kind of inspiration that we sorely need in confronting an uncertain future. Similar foresight, and similar leadership, is badly needed in the world today, with patterns of consumption and uses of technology that cannot be sustained. With vision, resources can always be found; without it, nothing can be accomplished. The organization of the California Desert Bill, which will leave such a significant heritage for future generations, provides a clear example of what such leadership can be. The challenge of using the unimaginable resources of this university community and this State to provide a worthy model for the solution of global problems transcends current economic woes, and provides a challenge of transcendent importance for local leaders at all levels.

In conclusion, it is worth mentioning once more the remarkable contributions of Willis Linn Jepson. Through a lifetime of perceptive studies, he gave us the first clear understanding of the flora of California. The joy that he felt in his boyhood in the Sacramento Valley, and in exploring the Vaca Mountains and further afield, we feel in coming together on this singular occasion, in the pleasure of being citizens of the most prosperous and blessed nation on Earth, of enjoying the beautiful plants that we have been discussing and the landscapes that they fill with greens, greys, and browns, and in the intellectual tools that we have gained, and which will help us to know more and more about these plants and the principles of our survival. Our privileged position brings with it opportunities, challenges, and obligations, ones that we shall be dealing with as well as we can for as long as we are able.

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